Chapter 1

Introduction

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This book demonstrates how economic principles can be used to analyze forest policy issues across existing and developing market economies. The majority of the chapters address timber production and timber markets, primarily from private forest lands. However, policy makers and forest owners are increasingly concerned with a wide range of forest outputs, including ecosystem services, amenities, recreation, and fuelwood, as well as timber. While many of these outputs are not traded in formal markets, the chapters in this book demonstrate that the market paradigm is a useful framework for examining the behavior and values of forest owners and users. Market concepts can be applied broadly to improve our understanding of public policy in the contentious arena of forest management.

Forest economics addresses the significance of forests to the economy, the impact of the economy on forests, and the means by which government and landowners achieve forest management goals. There are several factors that distinguish forest economics as a separate applied field of economics. First, the diversity of forest landowners, both by groups (public, and private industrial and nonindustrial) and within groups, leads to a diversity of preferences, expectations, and constraints. Second, the long time frames involved in forest production give rise to the classical problem of choosing optimal rotation lengths, capital budgeting, and modern financial analysis. A third complicating factor is that forests jointly produce multiple outputs, some extracted and some valued *in situ*, some traded in the market and some not, and some accruing to forest owners and some to the public. Those not traded in the market, whether consumed by landowners or by the public, have no market price signals to predict behavior or guide allocation. Fourth, the immobility of forests lends greater importance to the issue of market power and to travel costs as necessary inputs to forest use. These and other

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aspects of forest economics are reviewed in many textbooks, such as Buongiorno and Gilless (2003), Gregory (1987), Johansson and Lofgren (1985), Klemperer (1996), Nautiyal (1988), and Pearse (1990).

1. BACKGROUND AND PURPOSE

This book is designed as a handbook of applied, empirical forest economics for practitioners, policy analysts, and graduate students. The reader of this book is assumed to be familiar with basic market concepts, including marginal analysis of production and consumption decisions under profit and utility maximization. The chapters are designed for readers with a background in quantitative microeconomics (Varian 1999), introductory calculus (partial derivatives), and statistics including multivariate ordinary least squares regression (OLS) and common maximum likelihood estimation techniques such as probit and logit. All of the chapters provide references for the reader wishing to understand the methods in greater depth. Econometric textbooks such as Greene (2002) and Gujarati (1998) are recommended as general references. A more intuitive presentation of many of the methods can be found in Kennedy (1998).

The chapters encompass traditional and modern areas of concern in forest policy, explaining and illustrating how to apply a range of empirical analytical methods (table 1.1). The two chapters following this introduction summarize the status of the world's forests (chapter 2) and the state of research on private forest management (chapter 3). The rest of the book is divided into three sections. The first focuses on timber production, primarily from private US forest lands, and markets. The second addresses multiple use management and considers a diversity of forest owners and outputs. The third section focuses on the valuation of non-market benefits from forests, including stated and revealed preference methods. In each chapter, the goal is to demonstrate rigorous, policy-relevant, empirical analysis in a manner accessible to readers with a background in intermediate microeconomic theory and statistics.

2. ORGANIZATION OF THE BOOK

Traditional forest economics is concerned with producers who are assumed to maximize profits subject to production technology and exogenous prices. The chapters in the first section follow in that tradition, extending the basic theory (chapter 5) in several directions to more accurately model forest landowners' objectives and constraints by

Table 1.1. Chapter themes, data and methods

No.	Theme	Data and Location	Methods
2	Status of the world's forests	Aggregate Worldwide	Summary
3	Private forest management	Aggregate and micro US	Summary
4	Neotraditional optimal rotation	Micro North Carolina	Faustmann (logit)
5	Timber production and harvesting	Micro US South	Cost and production functions (OLS[a])
6	Forests and land as investments	Aggregate US	Modern portfolio theory - CAPM[b], efficient frontier, and option pricing
7	Efficient production frontiers	Micro US South	Stochastic frontier analysis (Math. programming, OLS[a])
8	Modeling aggregate timber supply	Aggregate US South	Timber supply from profit function (3-stage least squares)
9	Modeling aggregate timber demand	Aggregate US South	Derived demand from cost function (Seemingly unrelated regression)
10	Efficiency of timber markets	Aggregate US South	Law of One Price (OLS[a], ARIMA[c], Dickey-Fuller)
11	Trade in forest products	Aggregate Worldwide	Partial equilibrium trade models (simulation)
12	Timber harvests from public lands	Parameters from literature US	Engineering supply (simulation, smoothed by OLS[a])
13	Carbon sequestration	Parameters from literature US	Faustmann, land rent theory (simulation)
14	Timber and amenity as joint outputs	Aggregate and micro North Carolina	Household production (OLS[a] and probit)
15	Nontimber forest products	Household survey India and Brazil	Household production (OLS[a], Tobit, and neg. binomial)
16	Adoption of agroforestry	Household survey Mexico, Philippines	Household production, adoption choice (probit and logit)
17	Demand for forest ecosystem health	Household survey US South	Contingent valuation (bivariate probit)
18	Preferences for forest management	Household survey Maine	Stated preference, attribute based (multinomial logit)
19	Demand for forest recreation	Recreationist survey Brazil	Travel cost (poisson and negative binomial)
20	Ecosystem services as production inputs	Household survey Indonesia	Weak complementarity, derived demand (OLS[a])

[a]OLS=ordinary least squares [b]CAPM = Capital Asset Pricing Model
[c]ARIMA = autoregressive integrated moving average

incorporating risk (chapter 6), the possibility of inefficient production (chapter 7), and market power (chapter 10). The cumulative impacts of individual decisions are observed in markets, and the link between landowner decisions and market analysis is one theme of the first section. The section addresses markets for wood products, including aggregate supply (chapter 8), derived demand from domestic industry (chapter 9), and international trade (chapter 11). Recommended texts for background in production economics are Antle and Capalbo (1988) and Chambers (1988).

One key decision for forest landowners is rotation length, or when to harvest the timber from a given forest stand. The underlying theory of optimal rotations was developed by Faustmann (1849) and extended by Hartman (1976). This theoretical framework is introduced in the first section (chapter 4) and also underlies the first two chapters of the second section (chapters 12 and 13). The Faustmann solution provides the optimal harvest age for the deterministic case with positive financial income from timber harvests. Hartman expanded the analysis to examine tradeoffs between timber returns and other outputs such as amenities and ecosystem services. This and other issues of multiple-use are central to public forest land management in the US, which is addressed in chapter 12 of this book and in references such as Bowes and Krutilla (1989) and Loomis (1993).

The remaining chapters in the second section rely on the household production framework, in which economic agents are modelled as both producers and consumers of forest outputs (chapters 14, 15 and 16). This framework is appropriate for non-industrial private forest landowners in the US and for agricultural households in developing countries. These households use public forests and/or plant trees to obtain a variety of benefits. Where markets are complete, their production decisions can be modelled in the standard profit maximization framework, as demonstrated by the last chapter of the book (chapter 20). Key references on household production theory are Singh et al. (1986) and Sadoulet and deJanvry (1995). The other chapters in section three focus on demands for forest outputs and thus rely on consumer theory, or utility maximization and welfare estimation (chapters 17, 18, and 19). The standard reference for non-market valuation is Freeman (2003), with relevant econometric methods discussed in greater detail in Haab et al. (2002).

3. STUDY SITES AND DATA

Many of the chapters address forestry issues in the US South. Forest land in the South is a market driven, ecologically and culturally significant part of the regional landscape. It provides an excellent laboratory for examining

market influence on a diversity of landowners across a diverse landscape. The South has active markets for timber, and an increasing population with increasing demands for other forest outputs such as recreation and ecosystem services (Wear and Greis 2002). Several chapters consider other regions in the US (e.g., Maine), address the US as a whole, or are not specific to a region. Other chapters focus on developing countries (Brazil, India, Indonesia, Mexico, and the Phillipines). The literature reviewed in the most of the chapters is international, including many examples from Europe. Finally, the international trade chapter addresses the US at a national level in concert with other players in international markets.

The empirical examples in the chapters draw on data from various sources, including secondary data from the US and the South in particular. Examples include the Forest Inventory and Analysis of the USDA Forest Service, the Timber Mart-South price series (Norris Foundation), the Total Timberland Index of NCREIF (National Council of Real Estate Investment Fiduciaries), surveys of logging firms by the American Pulpwood Association, sector-specific producer price indices from the Bureau of Economic Analysis, and US Census of Population and of Manufacturers. Some chapters draw on other literature for parameters to use in simulations. The third type of data is from surveys of households or individuals conducted by the authors. By definition, survey data is required for stated preference valuation methods (chapters 17 and 18). All of the international applications (chapters 15, 16, 19, and 20) analyze household survey data, perhaps in part due to the lower cost of collecting data in developing countries. Deaton (1997) and Mukherjee et al. (1998) are excellent references for analysis of such household survey data.

4. SUMMARY

Most of the chapters present general theory and methodology relevant to a set of forest policy or management questions, review the findings of previous literature, and derive key testable hypotheses. These hypotheses are then tested in the context of case studies, using the variety of data sources and econometric or other quantitative methods described above. Thus, the results are both methodological and policy-related, and both specific to the case studies and generalizable. Table 1.2 lists selected findings from the chapters. Many of the chapters suggest areas for further work, either in testing hypotheses or advancing the methodology to address other issues and other regions of the world.

Table 1.2. Summary of key findings

No.	Theme	Findings
2	Status of the world's forests	The world has 3.9 billion ha of forests, 87% publicly owned, 5% in plantations, 43% with management plans.
3	Private forest management	Landowner and timber characteristics, market and policy variables determine private forest management.
4	Neotraditional optimal rotation	Neotraditional models are consistent with nonindustrial, traditional with industrial. Future rotations matter to both.
5	Timber production and harvesting	Estimated cost and production functions indicate only limited structural change within logging technology class, 1979-1987.
6	Forests and land as investments	Timberland provides portfolio diversification benefits and is attracting new capital from institutional investors.
7	Efficient production frontiers	Average technical efficiency approximately 60%, similar between years, but increasing over time.
8	Modeling aggregate timber supply	Structure and amount of forest inventory capital affect timber supply estimates; pulp & sawtimber supply respond differently.
9	Modeling aggregate timber demand	Heterogeneity of firms, from processing, input definition, or output definition, may drive observed aggregate relationships.
10	Efficiency of timber markets	Timber prices are temporally efficient. Some oligopsony exists in the pulpwood market.
11	Trade in forest products	Rapid growth in trade has been encouraged by trade agreements (NAFTA, WTO), but barriers still exist.
12	Timber harvests from public lands	Public intervention through harvesting increases public supply, reduces private supply, lowers price, increases price volatility.
13	Carbon sequestration	Prices for carbon sequestration influence optimal rotation age and land use allocation.
14	Timber and amenity as joint outputs	Joint production depends on plot, market and landowner factors and affects timber supply elasticities.
15	Nontimber forest products	NTFP collection driven by functional relationship to other household activities, preferences and assets.
16	Adoption of agroforestry	Market incentives, biophysical conditions, preferences, risk/uncertainty and resource endowments influence adoption.
17	Demand for forest ecosystem health	Forest condition is an economic good, and existence value is largest component of public value of spruce-fir forests.
18	Preferences for forest management	Maine general public prefers balance of harvest and protection and is WTP to protect more forest area.
19	Demand for forest recreation	Count data models adjusted to reflect characteristics of the trip decision demonstrate value of infrequent forest recreation.
20	Ecosystem services as production inputs	Micro theory helps identify data-efficient methods that show substantive contributions of forest ecosystem services.

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